PQF LV Active Filters: Bringing energy savings to you...
Key elements of poor LV Power Quality

- Harmonics
- Reactive power
- Load imbalance

Energy losses and high running costs
Customer inquiry

- Can ABB PQF active filters help to realize energy savings?

- The question becomes more popular with increasing energy prices

- The answer is...

→ 4 field reports...
Field report 1: Installation on ferries

The installation

Power plant: 2 generators
Main load: 2 DC drive propulsion units

Performance without filters:
G1: 660 A, G2: 580 A \( \cos \varphi \): 0.76
THDV = 22%, THDI = 25%
Av. consumption: 14000-15000 l/month

The inquiry

- Install filters to solve harmonic problems due to propulsion DC drives
- Perform \( \cos \varphi \) compensation without overcompensation
Field report 1: Installation on ferries

- Reasons for choosing ABB active filters
  - Compact solution (paramount given the limited space aboard)
  - Excellent filtering performance
  - Possibilities to perform transient-free reactive power compensation up to target $\cos \varphi$

- Customer findings and consequent actions
  - Technical problems resolved
  - With ABB PQF active filters operational, about 10% of fuel savings were reported resulting in drastically reduced running costs

- Further actions of customer and findings
  - Installation of ABB PQF active filters on other ferries of customer
  - 10% of fuel savings have also been confirmed on the other ferries

Customer gain: per ferry about 18000 l fuel per year
Customer

- Runs various extruder lines resulting in THDV of about 11% on LV side
- Extruder lines are DC drive based
- Due to the harmonics in the voltage, voltage wave form had multiple zero crossings which upset the DC drive control causing damage
- Hopes to have reduction of losses in (long) feeding cables and feeding transformers (billing aspect and cable overheating aspect)
Field report 2: Industrial extruder lines

- Reasons for choosing ABB active filters
  - Only supplier with long term track record for large power active filters
  - ABB in house engineering of the product giving confidence for future support
  - Possibility to set $\cos \varphi$ target value and possibility to assign resources to this task
Customer findings and consequent actions

- Technical problems in production line disappeared
- $\cos \varphi$ of the installation increased from 0.84 to 0.92 on average
- In house on-line power consumption monitoring indicated around 10-15% savings of active power which resulted in very short pay back time of installation

Extruder 4 - Active Power $P$ (kW)
(ABB Active Filter PQF OFF)

$P_{\text{min}} = 927$ kW
$P_{\text{max}} = 1230$ kW

Extruder 4 - Active Power $P$ (kW)
(ABB Active Filter PQF ON)

$P_{\text{min}} = 827$ kW
$P_{\text{max}} = 1147$ kW
Field report 2: Industrial extruder lines

- ABB verification measurement with high precision measuring equipment indicated that
  - measuring equipment used by the company functions correctly
  - during the verification measurement with and without active filter also around 11% power savings were recorded when filter running

- ABB contacted independent 3rd party European accredited measurement laboratory, ‘Labo Lemcko’ to re-measure and verify the validity of the measurements made...
Field report 2: Industrial extruder lines

Independent laboratory confirmed 14.5% energy savings!

Energy (kWh) vs Time (h)

![Energy graph showing savings with and without filter]

Customer gain: more than 70 kUSD per year

- **Transformer**:
  - Nominal power: 4000 kVA
  - Short-circuit impedance: 6%
  - Secondary Voltage: 400 V

- **Transformer-busbar cable**:
  - Length: 150 m
  - Cross section / phase: 300 mm²
  - Nr parallel connections: 14

- **MV Network**:
  - Short-circuit power: ? MVA
  - Voltage: 10 kV
  - Frequency: 50 Hz

- **Active Filter**:
  - Pulse number and type: 6 pulse IGBT
  - RMS Current: 450 A

- **Other Load**:
  - Not Measured! Inferior to main load

- **Main extruder 1**:
  - Pulse number and type: 6 pulse SCR
  - Apparent power: 750 kVA

- **Energy (kWh) vs Time (h)**

  - With filter
  - Without filter
## Financial analysis over time

<table>
<thead>
<tr>
<th>Year</th>
<th>Accumulated energy savings (kUSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt;70</td>
</tr>
<tr>
<td>2</td>
<td>&gt;140</td>
</tr>
<tr>
<td>3</td>
<td>&gt;210</td>
</tr>
<tr>
<td>4</td>
<td>&gt;280</td>
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<tr>
<td>...</td>
<td>...</td>
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</tbody>
</table>

Note: during the first year, the customer has already profit because the production line down time is reduced.

Very short pay-back time is realized
Field Report 2: Industrial extruder lines

- Further actions of customer
  - Customer has ordered additional ABB PQF LV Active Filters for other production lines
Field report 3: AC drives – paper industry

- **Customer**
  - Runs many AC drives and has set up an evaluation program of savings with and without active filter
  - Measurements were done over periods of one month with and without active filter (March: active filter not running, April: active filter running)
Field report 3: AC drives – paper industry

- Customer findings and consequent actions
  - Customer reports on average 10% savings when active filter is used
  - Customer is at present making inventory of all his harmonic loads and requests ABB to quote for an overall filter solution
Field report 4: stadium flood lights

Customer

- Needs to offload supply cables to the flood lights (overheating problem due to cable losses)
- Needs to ensure that system can run on stand alone generator basis due to international football organization rules
- Installs active filters to accommodate the above
Field report 4: stadium flood lights

- Customer findings
  - Cable losses are reduced by 33% resulting in acceptable operation
  - Technical problems (generator operation) are resolved

- Consequence
  - Reduction of cable losses has positive impact on energy bill
Large induction machine analysis

- For a 1 MW induction machine a loss evaluation with and without harmonics was made

- Conclusions for the machine considered
  - If supply voltage contains 10% H5 distortion, the losses in the machine (due to n.p.s. current) increase by approx. 10-13%
  - Temperature increase in the machine due to the losses is approx. 10 Kelvin

- Consequences
  - Loss increase in the machine has to be paid for
  - The lifetime of this machine is greatly reduced due to temperature increase
Conclusions

- More and more data emerge indicating that poor Power Quality of the electrical network results in substantially increased electrical losses and consequent down-time and financial loss.

- Field reports indicate that ABB PQF LV Active Filters offer an efficient solution to reduce down-time and bring substantial energy savings to customers.

PQF LV Active Filters
Bringing energy savings to you!
Power and productivity for a better world™